

We claim:

1. A catalytic composite for use in a catalytic distillation apparatus, the catalytic composite comprising:

- 5           a) a support structure, made of an inorganic oxide, having a void fraction ranging from 0.30 to 0.95, a surface area of from 40 m<sup>2</sup>/g to 500 m<sup>2</sup>/g, and a crush strength of from 2.4 to 9.9 kg per structure unit, the support structure having a shape selected from a ring, a  
10 hollow cylinder, a cross or multi partition ring or cylinder with 2, 3, or 4 cell partitions, a saddle, a solid ring, a solid cylinder, a sphere, and a honeycomb body; and
- b) from 0.01 to 10% by weight of a catalytically active species, based on the weight of the catalytic  
15 composite, which is deposited on the support structure.

2. The catalytic composite according to claim 1, wherein the void fraction is from 0.30 to 0.95, the surface area is from 50 m<sup>2</sup>/g to 500 m<sup>2</sup>/g, and the crush strength is from 2.4 to 9.9 kg per unit.

- 20   3. The catalytic composite according to claim 1 or 2, wherein the inorganic oxide is selected from the group consisting of alumina, silica, titania, zirconia and mixtures thereof.

4. The catalytic composite according to claim 1 or 2,  
25 wherein the inorganic oxide is  $\gamma$ -alumina.

5. The catalytic composite according to claim, wherein the inorganic oxide is  $\alpha$ -alumina.

6. The catalytic composite according to any one of claims 1 to 5, wherein the support structure is in the shape of a Raschig ring.

5 7. The catalytic composite according to any one of claims 1 to 6, wherein the catalytically active species comprises a group IV, V, VI, VII or a group VIII metal.

8. The catalytic composite according to any one of claims 1 to 6, wherein the catalytically active species comprises a group VI, a group VII or a group VIII metal.

10 9. The catalytic composite according to claim 8, wherein the catalytically active species comprises nickel.

10. The catalytic composite according to any one of claims 7 to 9, wherein the metal is in the form of a metal salt or a metal complex.

15 11. The catalytic composite according to claim 10, wherein the metal salt is in an ionic state.

12. The catalytic composite according to claim 10, wherein the metal salt is a metal sulphate, a metal phosphate, a metal oxalate or a metal acetate.

20 13. The catalytic composite according to any one of claims 1 to 6, wherein the catalytically active species is nickel sulphate.

25 14. The catalytic composite according to any one of claims 1 to 6, wherein the catalytically active species is nickel chloride.

15. The catalytic composite according to any one of claims 1 to 14, wherein the catalytically active species is in admixture with ammonium sulphate or ammonium phosphate.

16. The catalytic composite according to any one of claims 1 to 6, wherein the catalytically active species is an organic acid, an inorganic acid or a salt derived therefrom.

5 17. The catalytic composite according to claim 16, wherein the organic acid is methanesulfonic acid, toluenesulfonic acid, or trifluoroacetic acid.

10 18. The catalytic composite according to claim 16, wherein the inorganic acid is sulphuric acid or phosphoric acid.

19. The catalytic composite according to claim 16, wherein the salt is ammonium sulphate or ammonium phosphate.

15 20. The catalytic composite according to any one of claims 1 to 6, wherein the catalytically active species comprises a group VIII metal and a ligand, wherein the ligand comprises one or more atoms selected from the group consisting of carbon, hydrogen, oxygen, nitrogen and phosphorus.

20 21. The catalytic composite according to claim 20, wherein the group VIII metal is in the zero oxidation state.

25 22. The catalytic composite according to any one of claims 1 to 6, wherein the catalytically active species is palladium, platinum or rhodium.

23. , Use of a catalytic composite as claimed in any one of claims 1 to 22 as a packing material in a catalytic distillation column.

24. Use of a catalytic composite as claimed in any one of claims 1 to 22 as a catalyst in a catalytic distillation column.

25. A process for the selective oligomerization of a lower alkene to a C<sub>6</sub>-C<sub>18</sub> alkene, which process comprises contacting the lower alkene with a catalytic composite as claimed in any one of claims 1 to 22, under catalytic distillation conditions.

26. The process according to claim 25, wherein the lower alkene is selected from 1-butene, 2-butene and isobutene, and the C<sub>6</sub>-C<sub>12</sub> alkene is selected from trimethylpentene, n-octene, dimethylhexene and methylheptene.

27. The process according to claim 25 or 26, wherein the catalytic composite is admixed with inert distillation packing.

28. The process according to claim 27, wherein the ratio of the catalytic composite to inert distillation packing is from 10:1 to 1:10.

29. The process according to claim 27, wherein the catalytic composite and inert distillation packing are used in separate zones of the catalytic distillation column.

30. The process according to claim 25, wherein the lower alkene is a C<sub>4</sub> alkene and the C<sub>6</sub> to C<sub>18</sub> alkene is predominantly a C<sub>8</sub> alkene.

31. The process according to claim 30, wherein the C<sub>8</sub> alkene is a trimethylpentene.

32. A process for the hydrogenation of an alkene to an alkane, which process comprises contacting the alkene with

a catalytic composite as claimed in any one of claims 19 to 21, and hydrogen, under catalytic distillation conditions.

33. The process according to claim 32, wherein the alkene is selected from trimethylpentene, n-octene,  
5 dimethylhexene and methylheptene.

34. The process according to claim 31, wherein the catalytic composite is admixed with inert distillation packing.

35. The process according to claim 34, wherein the  
10 ratio of the catalytic composite to inert distillation packing is from 10:1 to 1:10.

36. The process according to claim 34 wherein the catalytic composite and inert distillation packing are used in separate zones of the catalytic distillation column.

15 37. The process according to any one of claims 32 to 35, wherein the alkene is trimethylpentene and the alkane is trimethylpentane.

38. A process for preparing high octane compounds, the process comprising:

20 a) contacting a C<sub>2</sub> to C<sub>6</sub> alkene with a catalytic composite as claimed in any one of claims 1 to 22, under catalytic distillation conditions, to obtain a C<sub>6</sub> to C<sub>18</sub> alkene; and

25 b) contacting the C<sub>6</sub> to C<sub>18</sub> alkene from step a) with a catalytic composite as claimed in any one of claims 19 to 21, and hydrogen, under catalytic distillation conditions, to obtain a C<sub>6</sub> to C<sub>18</sub> alkane.

39. The process according to claim 38, wherein the process steps a) and b) are carried out in a single catalytic distillation column.

40. The process according to claim 38, wherein the process steps a) and b) are carried out in separate catalytic distillation columns.

41. The process according to any one of claims 38 to 39, wherein the C<sub>2</sub> to C<sub>6</sub> alkene is a C<sub>4</sub> alkene and the C<sub>6</sub> to C<sub>18</sub> alkene is a C<sub>8</sub> alkene.

42. The process according to claim 41, wherein the C<sub>8</sub> alkene is trimethylpentene.

43. A process for preparing high octane compounds, the process comprising:

a) contacting isobutene with a catalytic composite as claimed in any one of claims 1 to 22, under catalytic distillation conditions, to obtain trimethylpentene; and

b) contacting trimethylpentene with a hydrogenation catalyst, and hydrogen, under batch reaction conditions or under hydrogenation reaction conditions to obtain trimethylpentane.

44. A process for the production of C<sub>6</sub>-C<sub>18</sub> alkenes, which process comprises contacting a mixture of C<sub>2</sub>-C<sub>6</sub> alkenes with a catalytic composite as claimed in any one of claims 1 to 22, under catalytic distillation conditions.

45. A process according to claim 44, wherein each C<sub>2</sub>-C<sub>6</sub> alkene in the mixture is oligomerized within different reactive zones found in a single catalytic distillation column.

46. A process according to claim 44, wherein each C<sub>2</sub>-C<sub>6</sub> alkene is oligomerized within different reactive zones found in two or more linked catalytic distillation column.

47. A process according to any one of claims 44 to 46,  
5 wherein the mixture of C<sub>2</sub>-C<sub>6</sub> alkenes comprises one or more C<sub>4</sub> alkenes.

48. A process for the selective oligomerization of a lower alkene to a C<sub>6</sub>-C<sub>18</sub> alkene, which process comprises contacting a mixture of C<sub>2</sub> to C<sub>6</sub> alkenes and C<sub>1</sub> to C<sub>6</sub>  
10 alkanes with a catalytic composite as claimed in any one of claims 1 to 22, under catalytic distillation conditions.

49. A catalytic composite for use as a hydrogenation catalyst in a catalytic distillation apparatus, the catalytic composite comprising:

15 a) a support structure, made of an inorganic oxide, having a void fraction ranging from 0.30 to 0.95 and a crush strength of from 2.4 to 9.9 kg per structure unit, the support structure having a shape selected from a ring, a hollow cylinder, a cross or multi partition ring or  
20 cylinder with 2, 3, or 4 cell partitions, a saddle, a solid ring, a solid cylinder, a sphere, and a honeycomb body; and

b) from 0.01 to 10% by weight of palladium, platinum or rhodium, based on the weight of the catalytic composite, which is deposited on the support structure.

25 50. The catalytic composite according to claim 49, wherein the inorganic oxide is  $\alpha$ -alumina.

51. The catalytic composite according to claim 50, wherein the  $\alpha$ -alumina has a surface area of from 0.1 to 1.0 m<sup>2</sup>/g.

52. A process for the hydrogenation of butadiene, the process comprising contacting butadiene with a catalytic composite as claimed in any one of claims 49 to 51, and hydrogen, under catalytic distillation conditions.

53. A process for the selective hydrogenation of methylacetylene and propadiene in a C3 fraction to provide propylene, the process comprising contacting the C3 fraction with a catalytic composite as claimed in any one of claims 49 to 51, and hydrogen, under catalytic distillation conditions.

54. A process for the selective hydrogenation of allene and propyne in a fluid catalytic cracking (FCC) stream, the process comprising contacting the FCC stream with a catalytic composite as claimed in any one of claims 49 to 51, and hydrogen, under catalytic distillation conditions.

55. A process for the selective hydrogenation of butadiene in a raffinate I or a raffinate II stream to provide a butene, the process comprising contacting the raffinate I or the raffinate II stream with a catalytic composite as claimed in any one of claims 49 to 51, and hydrogen, under catalytic distillation conditions.